THE CHEMICAL SENSITIVITY OF LAKES TO ACIDIC DEPOSITION AND THE RISK TO FISH POPULATIONS

NORTHWESTERN REGION

ONTARIO FISHERIES ACIDIFICATION REPORT SERIES NO. 86-06

Debbie Conrad

1986

Ontario
Ministry of Natural Resources

Hon. Vincent G. Kerrio
Minister

Mary Mogford
Deputy Minister

ISSN 0832-7629
ISBN 0-7729-1789-2

ONTARIO FISHERIES ACIDIFICATION REPORT SERIES

The Ontario Fisheries Acidification Report Series has been established by the Ontario Ministry of Natural Resources to document findings from studies conducted as part of the Fisheries Acidification Program. These reports are intended to contribute to our knowledge of acidification effects, but they should also be of general interest to fisheries managers.

These reports are basically progress reports. Much of this information will appear later in journal papers.

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Printed in Ontario, Canada

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Ministry of Natural Resources
Fisheries Branch, Queen's Park
Toronto, Ontario M7A 1W3
Telephone: (416) 965-5947

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1.0 Introduction

In 1982, the Ministry of Natural Resources in cooperation with the Ministry of Environment initiated the Extensive Survey as part of the Fisheries Acidic Precipitation Program. The major objective of this survey was to create a data set which could be used by biologists and resource managers to predict the chemical sensitivity of Ontario's lakes to acidic deposition and the risk to fish populations. Under this program two data sets were created:

1) the Sensitivity Data Set, which contains water chemistry data from about 4500 lakes in the province.

2) the Comprehensive Data Set, which contains data on fish species presence, lake water chemistry and lake morphometry from approximately 3000 lakes in the province.

In this report these two data bases are used to describe the acid sensitivity of lakes sampled in Northwestern Region and the risk to sport fish species. Reports are also available for the Algonquin, North Central, Northern and Northeastern regions.

2.0 Methods

Eighty-three percent of the lake water samples were collected using the tube composite sampling method (MOE 1979) which provides a reasonably accurate measure of whole lake water chemistry (MOE 1979). Samples were collected in the centre of the lake over the period from 1978 to 1984. Since 44.1% and 43.7% of the lakes were sampled in the summer and fall/winter, respectively, very few observations reflect worst case water chemical conditions that may occur in the spring due to snowmelt (Jeffries et al. 1980, Gunn and Keller 1984). pH and total inflection point alkalinity were measured using either field meters accurate to +- 0.01 pH units (MOE 1979) or at federal and provincial laboratories (MOE 1981 and Env. Can. 1979). All other parameters were analyzed at government laboratories. Fish species presence data originated from the Aquatic Habitat Inventory Program (Dodge et al. 1985).

2.1 DISTRIBUTION OF SAMPLES

2.1.1 By District

The number of lakes sampled in each MNR administrative district, included in the Sensitivity Data Set, is shown in Figure 1. The sample size is largest for the Algonquin Park (N=538; including lakes both inside and outside the Algonquin Park boundary) and Bracebridge (N=413) districts. The sample size is lowest for Red Lake (N=11) and Ignace (N=13) districts.

Lake sampling in the Northwestern Region was limited (N=177), with most lakes sampled in the Dryden (N=50) and Kenora (N=52) districts. The lowest number of lakes sampled were in the Red Lake District.

2.1.2 By Size Class

The size distribution of sampled lakes for all of Ontario and for the Northwestern Region, is shown in Figure 2. Of the total number of lakes sampled in Ontario, the highest percentage (48.7%) are 10-99 ha in size. Approximately 33% are 100-999 ha, and 11.51% and 6.5% are in the size classes (1-9 ha) and (>=1000

ha), respectively. Although only 11.51% of the lakes sampled in all of Ontario are 1-9 ha in size, 68.7% of the total number of lakes in Ontario actually occur in this size class (Cox 1978). There is therefore an under-representation of small lakes in our current data set. As smaller lakes are more vulnerable to acidification than larger lakes (Minns 1981), this report may underestimate the total number of lakes at risk due to acidification stress.

Figure 3 shows that in the Fort Francis, Ignace and Red Lake districts, only lakes >=100 ha were sampled. In the Sioux Lookout District, the largest percentage of lakes sampled are in the >=1000 ha size class.

3.0 DEPOSITION

pH is measured on a scale from 1 to 14, with a pH of 7 being neutral. A pH of 1 indicates a very acidic solution while a solution of pH 13 is very alkaline. Clear, unpolluted rain is slightly acidic with a pH of approximately 5.6. The pH scale is logarithmic and therefore a pH of 4 is 10 times more acidic than a pH of 5, and 100 times more acidic than a pH of 6.

The weighted mean annual precipitation pH for each MNR region is illustrated in Figure 4. The pH isopleths were derived from deposition data reported by the Ministry of Environment (1983), and adjusted southwards to conform to MNR

district boundaries according to the method used by Minns (1981). For this report, districts lying south of the pH 4.3 isopleth receive a mean annual precipitation pH of less than 4.3. The Northeastern and Algonquin regions are located mainly in this deposition zone. The Northern, Northwestern and North Central regions are located north of the 4.3 isopleth and therefore receive a mean annual precipitation pH > 4.3. Deposition data from MOE sampling stations shows that Northwestern Region receives a mean annual precipitation pH of between 4.9 and 5.1 (MOE 1983).

The Sudbury deposition zone historically received high loadings of sulphur dioxide due to local smelting operations (Dillon et al. 1980, Keller et al. 1980). In recent years, water quality in many lakes in this area has begun to improve. Increases in pH and total inflection point alkalinity (TIA) and decreases in sulphate (SO4) reflect reduced deposition from the Sudbury smelting industry (Keller and Pitblado 1984). This zone is approximately delineated by longitudes 80'00 and 81'30 and latitudes 46'00 and 47'30. The MNR districts of Gogama, North Bay, Sudbury, and Temagami are located largely in the Sudbury deposition zone.

4.0 CHEMICAL SENSITIVITY

The type of bedrock and surficial sediment in an area and the neutralizing capacity of surface waters determines its chemical sensitivity to acidic deposition. Highly sensitive areas are located on non-calcareous granite, granite gneiss, orthoquartzite or syenite (Shilts 1981). The Canadian Shield is largely underlain by this non-calcareous bedrock. Areas located on limestone based bedrock are less sensitive to acidic deposition (Shilts 1981).

Figure 5 shows that most of the area in the Northwestern, North Central, Northern, Northeastern and Algonquin regions is highly sensitive to acid precipitation.

The chemical influence of non-calcareous underlying bedrock may be masked by glacially transported calcareous till (overburden) (Shilts 1981). Some lakes northeast of Lake Superior (ie. in Northern Region) are a good example of this. These lakes, despite their underlying acid sensitive bedrock, are alkaline in nature because of the effects of overburden (Shilts 1981). The buffering capacity of the glacial cover depends on its thickness and composition (Shilts 1981). Hence, lakes in close proximity to one another may differ in their chemical sensitivities with respect to acidic deposition. Because of this, large scale mapping (eg. Figure 5) cannot be used to accurately classify lakes in small management zones

(Brousseau et al. 1985).

5.0 TOTAL INFLECTION POINT ALKALINITY

Alkalinity is a measure of the acid neutralizing capacity of water (MOE 1982).

The Ministry of the Environment (1982) has subjectively established the following five sensitivity categories based on total inflection point alkalinity and has described the associated biological effects:

Acidified Lakes (TIA <=0 ueq/l)

These lakes usually have pHs below 5.0. Fish populations will be severely stressed and many species may be lost. Clams, snails and many amphibians may be absent. Algal matts may accumulate in the inshore area.

Extremely Sensitive (0 <TIA <=40 ueq/l)

During snowmelt, pH levels may be severely depressed and aluminum concentrations increased in nearshore areas, creating potentially toxic conditions for aquatic biota.

Moderate Sensitivity (40 <TIA <=200 ueq/l)

During most of the year, the water quality of these lakes

is not harmful to fish. In high acid deposition areas, however, the pH may be depressed in the nearshore areas of certain lakes during snowmelt.

Low Sensitivity (200 <TIA <=500 ueq/l)

These lakes generally experience low pH only under very extreme snowmelt conditions.

Not Sensitive (TIA >500 ueq/l)

These lakes contain enough buffering capacity to neutralize current levels of acidic precipitation.

Based on the above MOE classifications, 34.46% of the lakes sampled in the Northwestern Region are moderately sensitive to acidification (Figure 6). Approximately 36% are classified as having a low sensitivity to acidification and 29.38% are not sensitive to acidic deposition. Only 1 (0.56%) of the sampled lakes, Elga Lake in the Sioux Lookout District, is extremely sensitive to acidification (pH=6.1, TIA=1.9 mg/l, conductivity=16.0 umhos/cm). No lakes sampled are acidified.

Figure 7 shows the distribution of sampled lakes in each alkalinity class by district. Ignace (53.85%) and Dryden (52%) districts have the highest percentages of non sensitive lakes while Kenora District has the lowest (13.46%) in the region.

6.0 pH

As a lake acidifies, acid sensitive species such as walleye (Stizostedion vitreum), smallmouth bass (Micropterus dolomieu), and lake trout (Salvelinus namaycush) may be impaired at pHs below 5.5 (Beamish 1976, Harvey 1980, Beggs et al. 1986). More acid tolerant species such as the rock bass (Ambloplites rupestris), and yellow perch (Perca flavescens), may respond to lake acidification with increased growth and/or population size, at least temporarily (Harvey 1980). These species will eventually disappear if water quality deteriorates further (Harvey 1980).

To examine the data on lake pH and compare regions, we have categorized pH into four arbitrarily selected classes: (less than 5.0, 5.0-5.49, 5.5-5.99, >=6.0). The majority of pH values used in this report were obtained from either summer, fall or winter composite samples and therefore do not represent the minimum pH levels that can occur during episodic events, such as spring snowmelt (Jeffries et al. 1979).

Figure 6 shows that 100% of the lakes sampled in the Northwestern Region have a pH >=5.5, suggesting that fish populations in these lakes are currently not impaired by acidification.

7.0 SULPHATE

The sulphate (SO4) concentration found in water is related to the atmospheric deposition of sulphuric oxides, principle components of acid precipitation (MOI 1981). Sulphate may be deposited locally after undergoing chemical transformation, or it may be transported long distances by air currents before settling (Mulvaney and Hadden 1981).

The median SO4 concentrations for lakes sampled in the Northwestern, North Central, Northern, Northeastern, and Algonquin regions were all above the background sulphate level of 3.0 mg/l, postulated by Dillon (1983) to be typical of remote Canadian shield lakes not affected by long range air pollution. The median SO4 concentration is 3.50 mg/l for the Northwestern Region, low compared to that of 11.0 mg/l for lakes in the Sudbury zone. Of the lakes sampled in Northwestern Region, 78% have SO4 concentrations above 3.0 mg/l compared with 99.74% in Algonquin Region, which is located in an area of higher deposition.(Figure 8).

Based on these SO4 concentrations, a smaller proportion of lakes in the Northwestern Region are potentially stressed when compared to the Northeastern and Algonquin regions.

Figure 9 shows that in the Northwestern Region, the Fort Francis District has the highest percentage (82.35%) of lakes sampled above 3.0 mg/l SO4.

Districts with a sample size less than 20 were not included

in this analysis because a small sample size may not be representative of lakes in the entire region. Hence Ignace, Red Lake and Sioux Lookout districts were omitted from Figure 9.

8.0 TOTAL ALUMINUM

Metals, such as aluminum (Al), are found in elevated concentrations in low pH lakes (Wright and Gjessing 1976); hence there is a strong inverse relationship between pH and aluminum concentrations in lakes (Baker 1982). Both field and laboratory studies have shown that the death of fish in acidic waters can be attributed, not only to low pH levels, but also to elevated concentrations of inorganic aluminum (Baker 1982, Odonell et al. 1984). At a pH of 5.0 to 5.2, aluminum has been found to be toxic in low concentrations. Concentrations of 0.1 mg/l and 0.2 mg/l inorganic aluminum are acutely toxic to white sucker and brook trout fry, respectively (Driscoll et al. 1980, Baker and Schofield 1982).

Both osmoregulatory stress, due to impaired ion exchange, and respiratory distress, caused by mucous clogging of gills and gill damage, are associated with aluminum toxicity (Baker 1982).

In this data set total Al was measured; total Al being comprised of inorganic and organic forms (Baker 1982). The organically complexed form is less toxic to fish than the

inorganic form (Baker 1982). Measurements of total Al may therefore substantially overestimate the potential toxicity to fish (Baker 1982).

Based on the above, lakes sampled with total Al>=0.1 mg/l (the lower limit of toxic effect for fish) were charted for each region (Figure 10).

In the Northwestern Region, only a very small percentage (3.77%) of the sampled lakes have Al>=0.1 mg/l (Figure 10). The median aluminum concentration for sampled lakes in this region is 0.022 mg/l compared with 0.080 mg/l for lakes in the Sudbury loadzone. Since the pH for most of the lakes sampled in this region is above the critical pH (pH >6.0) and Al concentrations are largely below lethal concentrations (Al<0.1 mg/l), it is unlikely that many of the fish populations in this region have been adversely affected by aluminum toxicity.

In the Red Lake District, all sampled lakes have Al concentrations <0.1 mg/l. Dryden, Fort Francis, Ignace, Red Lake and Sioux Lookout districts were omitted from this analysis because they had a sample size of less than 20.

9.0 RESOURCES AT RISK

The current status of various sport fish lakes and the sensitivity of these lakes to future acidification is examined in order to determine the potential loss to sport fisheries on

both a regional and district scale. Lake trout, brook trout (Salvelinus fontinalis), smallmouth bass, lake whitefish (Coregonus clupeaformis) and walleye lakes are considered because of their importance to anglers. The percentage of sport fish lakes falling into each pH/alkalinity category was used to determine the resources at risk due to acidification. The alkalinity categories used in this section were modified from those of MOE (1982) which were used in the previous analyses. Since no evidence has been found for fisheries loss at TIA >=40 ueq/l, we consider only 3 alkalinity classes (TIA<=0, 0<TIA<40, TIA>=40 ueq/l).

9.1 Lake Trout

Lake trout, one of the most acid sensitive species (Harvey 1975, Beamish 1976 and Beggs et al. 1985), is found throughout the Canadian shield area of Ontario (Figure 11). Of the total number of lake trout lakes, 55% occur in the area of highest deposition (Beggs et al. 1985).

The pH threshold, below which lake trout are impaired due to acidification, was found to be 5.5 by Beggs et al. (1985), Schindler et al. (1985) and Beamish (1976). In the Northwestern Region, 100% (N=82) of the sampled lake trout lakes have a pH >6.0 and are moderately sensitive or not sensitive to acidification stress based on our TIA classification (Figure

12). Thus, it appears that the lake trout fishery in this region is currently not impaired by acidification since all sampled lakes are above the pH threshold of 5.5, and have alkalinities of >40 ueq/l.

9.2 Smallmouth Bass

Smallmouth bass lakes are largely concentrated in southcentral Ontario, the area of highest acid loadings (Figure 13). The distribution of this species is limited by northern latitudes because of the importance of temperature on the population dynamics of this species (Shuter et al. 1980).

Beggs et al. (1986) showed mortality of overwintering young of the year smallmouth bass likely occurs at pHs below 5.15. Harvey (1980) found successful reproduction in this species was impaired at pH 5.3. Figure 12 shows that 100% of the smallmouth bass lakes in the Northwestern Region have pHs >=6.0 and alkalinities >=40 ueq/l, suggesting that smallmouth bass populations in these lakes are presently not impaired by acidic deposition.

9.3 Lake Whitefish

Figure 14 illustrates that lake whitefish lakes are widely distributed throughout Ontario.

Preliminary results of laboratory experiments suggest that the pH threshold for lake whitefish fry held in waters of calcium=3.5 mg/l is approximately 4.5 (P. Ihssen pers. comm.). This threshold pH compares favourably with Harvey's findings (pH 4.5) for lake whitefish in the LaCloche mountain lakes (Harvey 1979). However, in a netting survey of Grace Lake (pH 4.93) in Northeastern Region, only two mature whitefish were captured, suggesting the population is small and no longer recruiting (V. Liimatainen pers. comm.). We therefore assume the threshold for lake whitefish to be pH 5.0.

All (N=81) sampled lake whitefish lakes in the Northwestern Region have a pH >=6.0 and are moderately sensitive or not sensitive to acidification based on our TIA classes. Therefore, it would appear that lake whitefish populations are not impaired by acidic deposition. (Figure 12).

9.4 Walleye

Walleye are widely distributed throughout Ontario (Figure 15). This species, although tolerant of a great range of environmental conditions, appears to reach greatest abundance in large shallow, turbid lakes (Scott and Crossman 1973).

Beamish (1976) observed walleye populations to decline or disappear between a pH of 5.5 and 6.0. Figure 12 shows that 100% (N=98) of the sampled walleye lakes in the Northwestern Region have a pH >=6.0 and are moderately sensitive or not sensitive to acidification. Since walleye are at risk due to acidification when the pH is below 6.0 (Hulsman et al. 1985), we would predict that the walleye fishery in this region is not impaired by acidification.

10.0 SUMMARY

Deposition data from MOE sampling stations shows that the Northwestern Region receives a mean annual rain pH of between 4.9 and 5.1 (MOE 1983). This is 3 to 5 times more acidic than pure rain unaffected by long range transport (pH 5.6).

Sulphate levels in 77.33% of the sampled lakes within the region are above background levels; therefore, a large portion of the lakes in this region have been affected by long range

transport of sulphuric oxides.

Based on alkalinity classes, the majority (99.44%) of lakes sampled in this region are well buffered, being moderately to not sensitive to acidification. Only one of the sampled lakes, Elga Lake in Sioux Lookout District, is extremely sensitive to acidification. No lakes sampled are acidified.

In the Northwestern Region, 100% of the lakes sampled have pHs >=5.5, suggesting that fish populations in this region are currently not impaired by acidic deposition.

ACKNOWLEDGEMENTS

I wish to thank G. Beggs, D. Wales and the Fisheries Assessment Unit leaders from MNR; J. Beaver, P. Dillon, M. German, B. Keller and L. Maki from MOE and H. Harvey and A. Zimmerman from the University of Toronto for the provision of water chemistry data. I would also like to thank G. Beggs, C. Brousseau, J. Gunn, M. McMurtry and especially D. Wales for providing constructive reviews.

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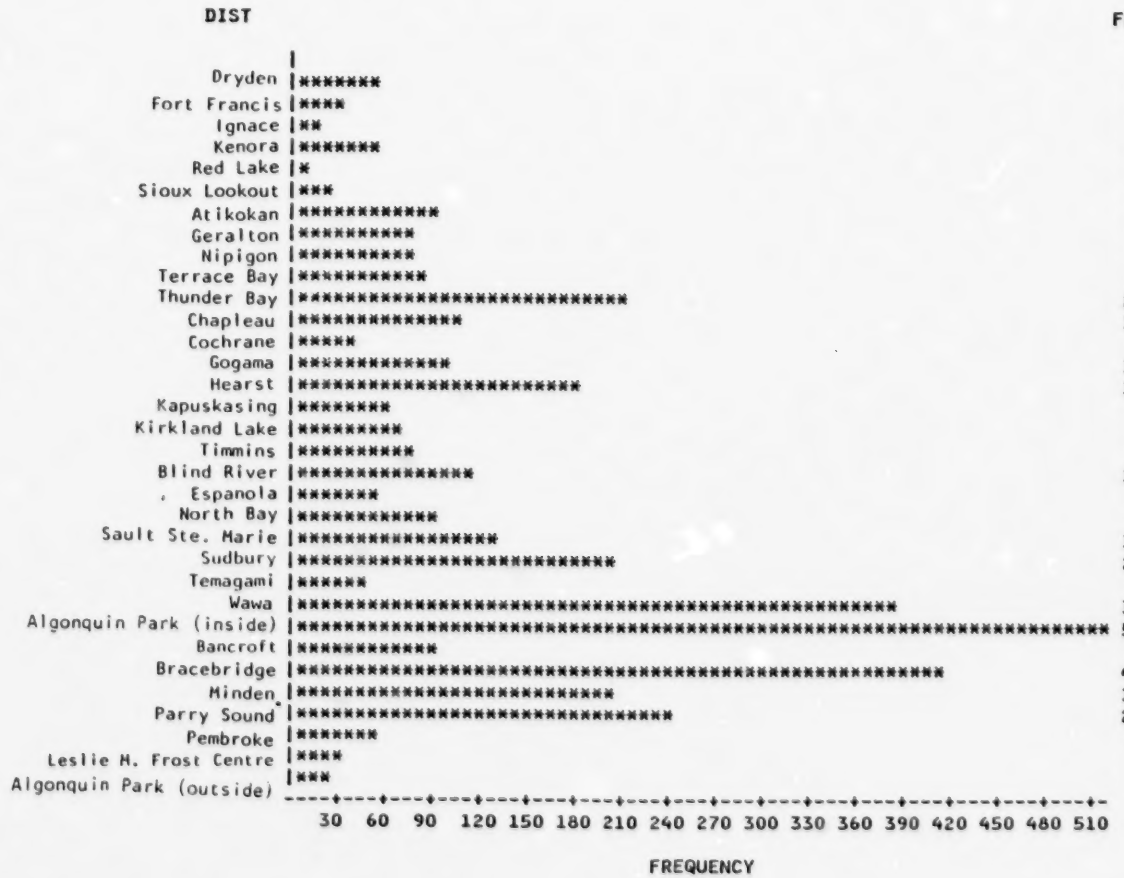
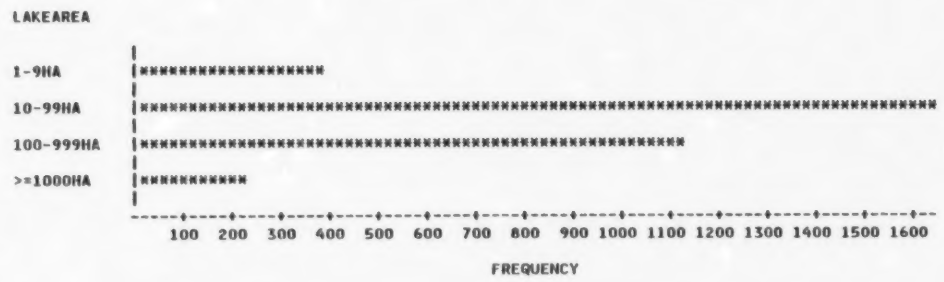
FIGURE 1: THE NUMBER OF LAKES SAMPLED IN EACH MNR ADMINISTRATIVE DISTRICT FROM THE SENSITIVITY DATA SET.



DIST	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
Dryden	50	50	1.27	1.27
Fort Francis	29	79	0.74	2.01
Ignace	13	92	0.33	2.34
Kenora	52	144	1.33	3.67
Red Lake	11	155	0.28	3.95
Sioux Lookout	22	177	0.56	4.51
Atikokan	88	265	2.24	6.75
Geralton	76	341	1.94	8.69
Nipigon	77	418	1.96	10.65
Terrace Bay	84	502	2.14	12.79
Thunder Bay	207	709	5.28	18.07
Chapleau	103	812	2.62	20.69
Cochrane	40	852	1.02	21.71
Gogama	101	953	2.57	24.29
Hearst	177	1130	4.51	28.80
Kapuskasing	63	1193	1.61	30.40
Kirkland Lake	69	1262	1.76	32.16
Timmins	74	1336	1.89	34.05
Blind River	115	1451	2.93	36.98
Espanola	49	1500	1.25	38.23
North Bay	91	1591	2.32	40.55
Sault Ste. Marie	129	1720	3.29	43.83
Sudbury	203	1923	5.17	49.01
Temagami	48	1971	1.22	50.23
Wawa	384	2355	9.79	60.02
Algonquin Park (inside)	515	2870	13.12	73.14
Bancroft	93	2963	2.37	75.51
Bracebridge	413	3376	10.52	86.03
Minden	199	3575	5.07	91.11
Parry Sound	242	3817	6.17	97.27
Pembroke	54	3871	1.38	98.65
Leslie M. Frost Centre	30	3901	0.76	99.41
Algonquin Park (outside)	23	3924	0.59	100.00

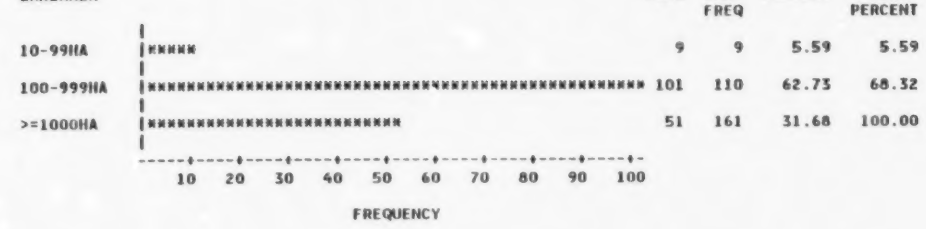
NOTE: NOT ALL LAKES SAMPLED HAVE DATA FOR EACH OF THE VARIABLES (IE. LAKE AREA ETC.), THEREFORE THE TOTAL NUMBERS OF LAKES SAMPLED, SHOWN IN SUBSEQUENT FIGURES, MAY BE DIFFERENT.

FIGURE 2: THE PERCENTAGE OF SAMPLED LAKES IN EACH LAKE AREA CLASS - FOR ALL OF ONTARIO.



LAKEAREA	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1-9HA	386	386	11.51	11.51
10-99HA	1633	2019	48.70	60.21
100-999HA	1116	3135	33.28	93.50
>=1000HA	218	3353	6.50	100.00

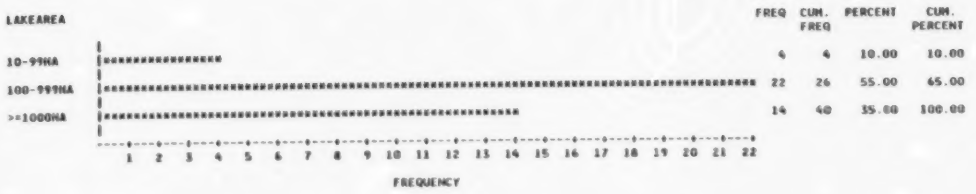
FOR NORTHWESTERN REGION



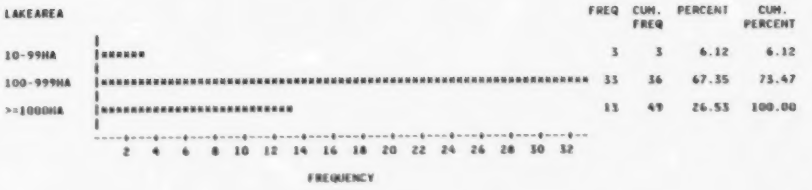
LAKEAREA	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
10-99HA	9	9	5.59	5.59
100-999HA	101	110	62.73	68.32
>=1000HA	51	161	31.68	100.00

FIGURE 3: THE PERCENTAGE OF SAMPLED LAKES IN EACH LAKE AREA CLASS BY DISTRICT.

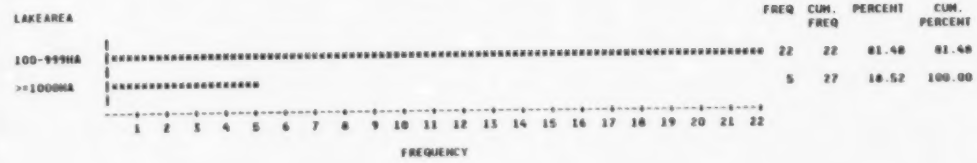
Dryden



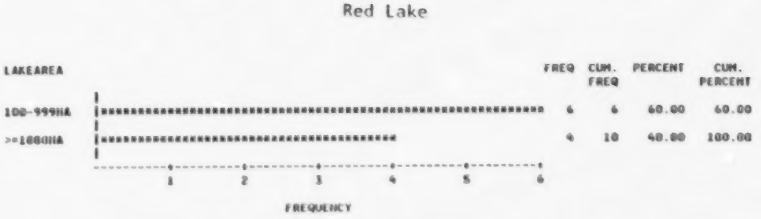
Kenora



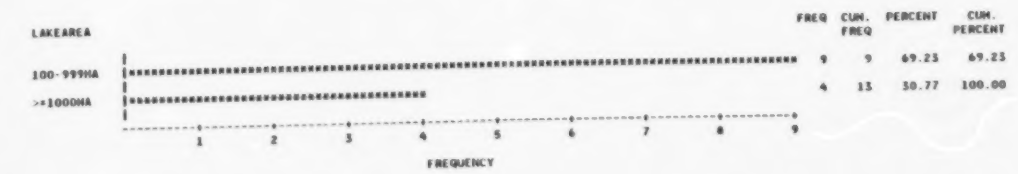
Fort Francis



Red Lake



Ignace



Sioux Lookout

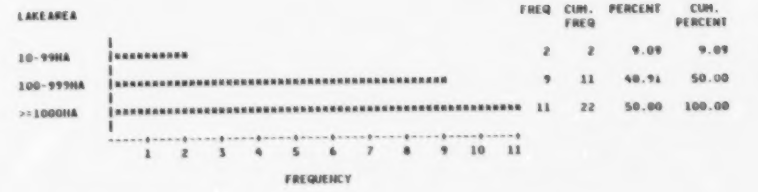


FIGURE 4: MNR ADMINISTRATIVE DISTRICT MAP WITH ADJUSTED PH ISOPLETHS AND THE SUDBURY DEPOSITION ZONE SUPERIMPOSED.

FIGURE 5: THE CHEMICAL SENSITIVITY TO ACID PRECIPITATION BASED ON THE COMPOSITION OF SOILS AND BEDROCK (FROM SHILTS 1981).

HIGH SENSITIVITY

Granite, granite gneiss, orthoquartzite, syenite

INTERMEDIATE-HIGH SENSITIVITY

Volcanic rocks, shales, greywacke sandstones, ultramafic rocks, gabbro, mudstone and metamorphic equivalents

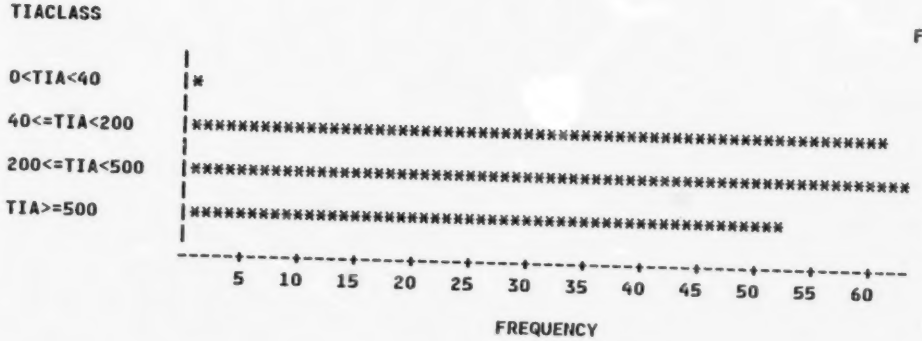
INTERMEDIATE-LOW SENSITIVITY

Calcareous clastic rocks and carbonate rocks interbedded or interspersed with noncalcareous sedimentary, igneous and metamorphic rocks

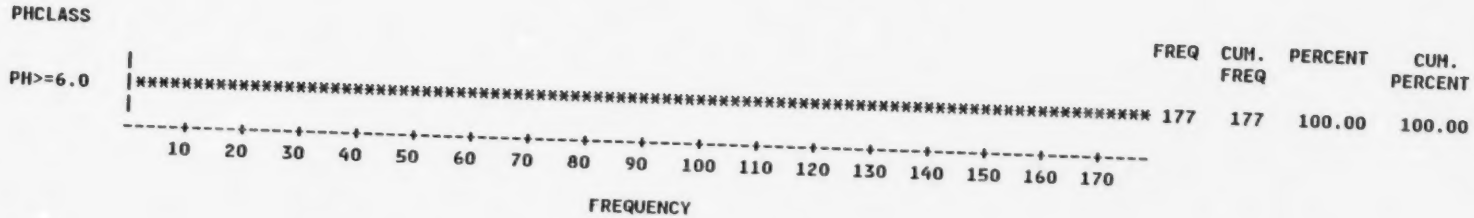
LOW SENSITIVITY

Limestone, dolomite and metamorphic equivalents

FIGURE 6: ALKALINITY AND PH CLASS OF SAMPLED LAKES IN THE NORTHWESTERN REGION.



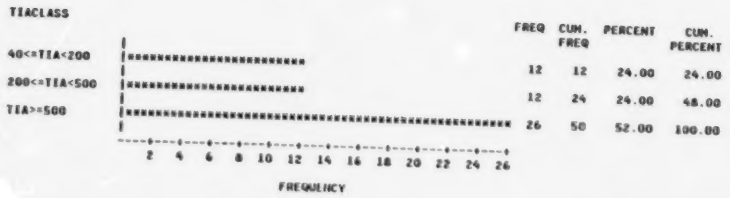
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0<TIA<40	1	1	0.56	0.56
40<=TIA<200	61	62	34.46	35.03
200<=TIA<500	63	125	35.59	70.62
TIA>=500	52	177	29.38	100.00



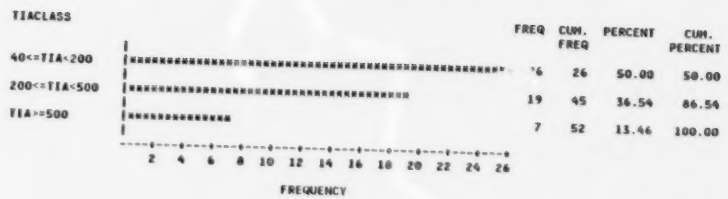
	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
PH>=6.0	177	177	100.00	100.00

FIGURE 7: THE PERCENTAGE OF SAMPLED LAKES IN EACH ALKALINITY CLASS BY DISTRICT.

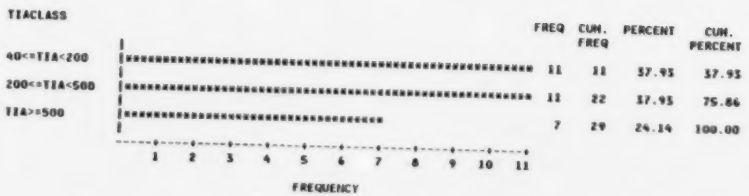
Dryden



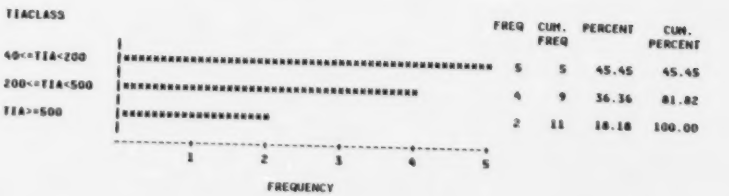
Kenora



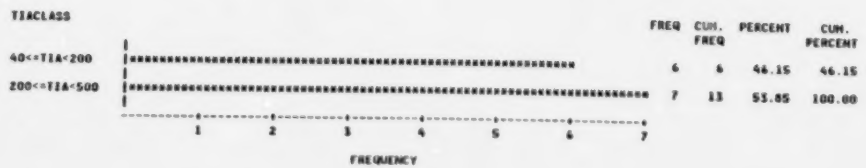
Fort Francis



Red Lake



Ignace



Sioux Lookout

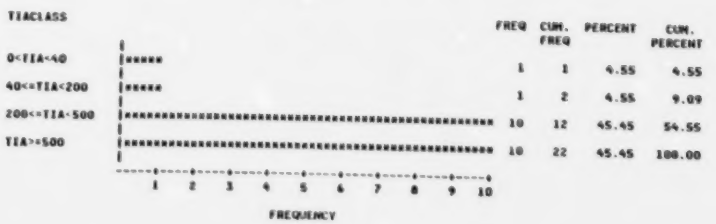
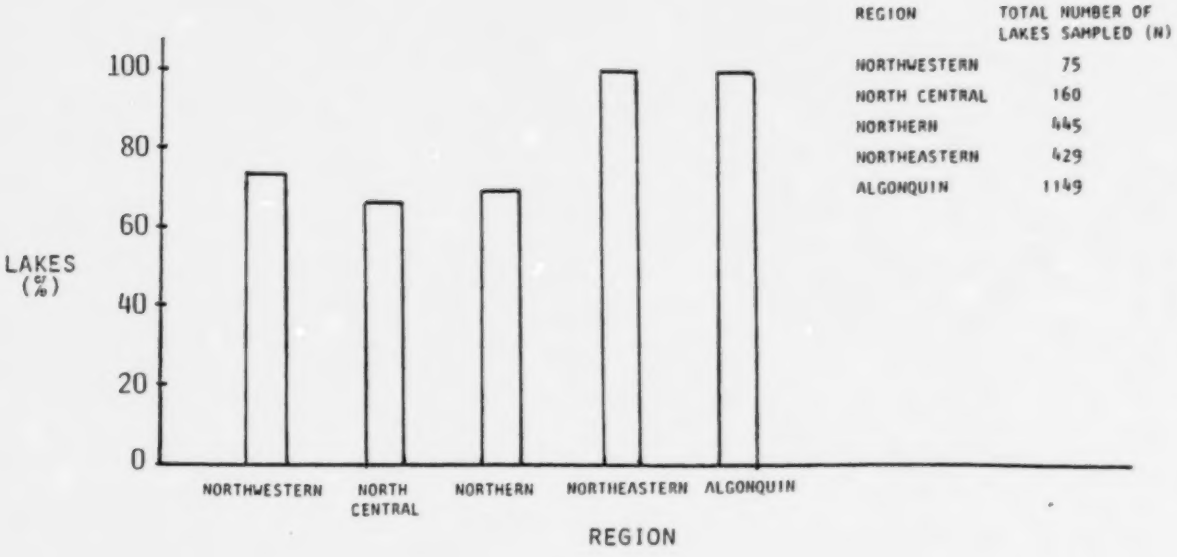


FIGURE 8: PERCENTAGE OF SAMPLED LAKES ABOVE THE BACKGROUND LEVEL OF 3.0 MG/L SO_4 - BY REGION.

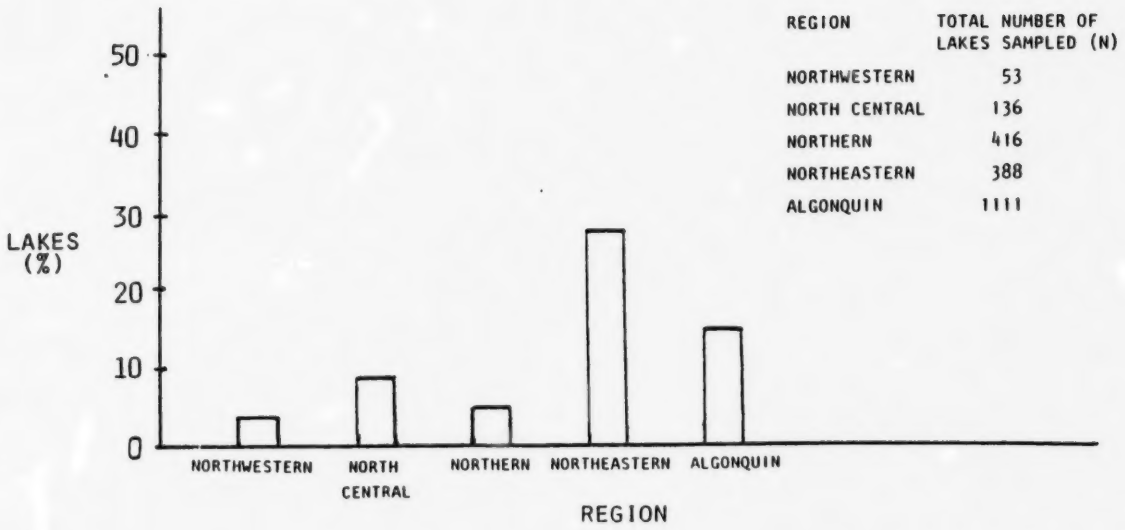


REGION	TOTAL NUMBER OF LAKES SAMPLED (N)
NORTHWESTERN	75
NORTH CENTRAL	160
NORTHERN	445
NORTHEASTERN	429
ALGONQUIN	1149

FIGURE 9: PERCENTAGE OF SAMPLED LAKES ABOVE THE BACKGROUND LEVEL OF 3.0 MG/L SO_4 - BY DISTRICT.

DISTRICT	TOTAL NUMBER OF LAKES SAMPLED (N)
FORT FRANCIS	22
KENORA	34

FIGURE 10: PERCENTAGE OF SAMPLED LAKES WITH TOTAL ALUMINUM >= 0.1 MG/L (LOWER LIMIT OF TOXIC EFFECT) - BY REGION.



REGION	TOTAL NUMBER OF LAKES SAMPLED (N)
NORTHWESTERN	53
NORTH CENTRAL	136
NORTHERN	416
NORTHEASTERN	388
ALGONQUIN	1111

FIGURE 11: DISTRIBUTION OF LAKE TROUT LAKES IN ONTARIO SAMPLED FOR ANALYSIS OF WATER CHEMISTRY.

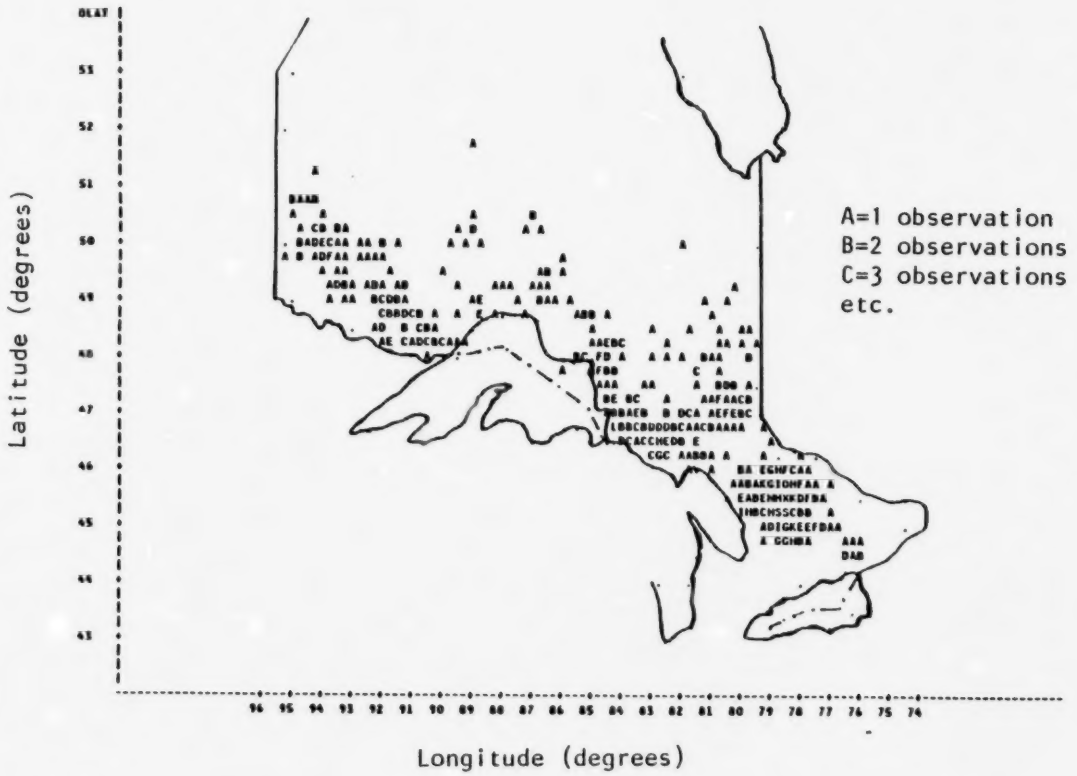
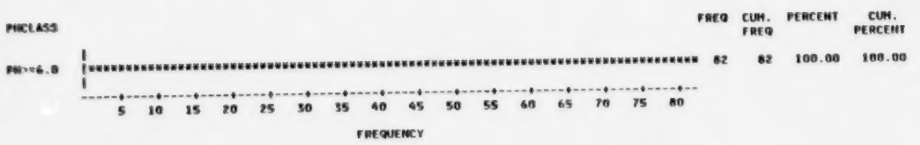
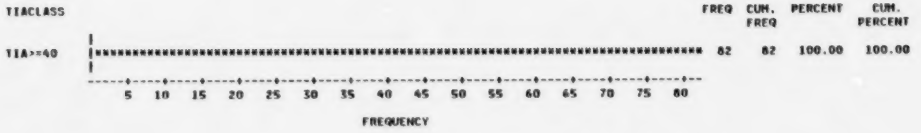


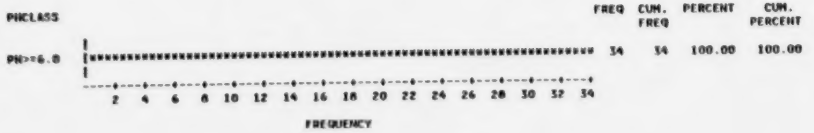
FIGURE 12: THE PERCENTAGE OF SAMPLED LAKE TROUT, SMALLMOUTH BASS, LAKE WHITEFISH AND WALLEYE LAKES IN TIA/PH CLASSES - NORTHWESTERN REGION.

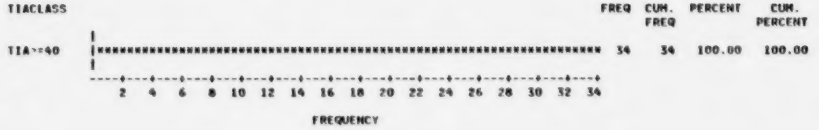
LAKE TROUT



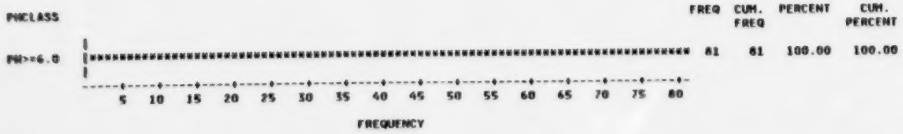


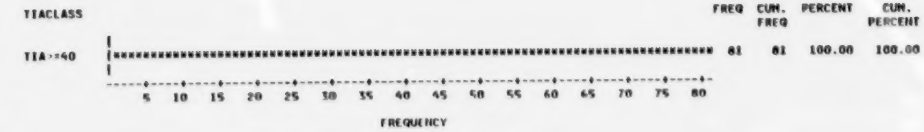
SMALLMOUTH BASS



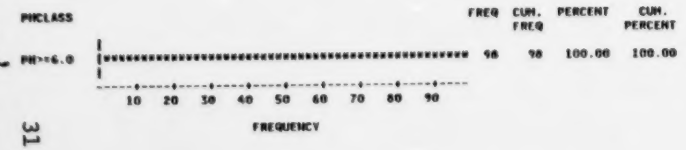


LAKE WHITEFISH





WALLEYE



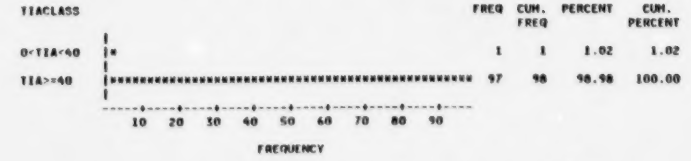


FIGURE 13: DISTRIBUTION OF SMALLMOUTH BASS LAKES IN ONTARIO SAMPLED FOR ANALYSIS OF WATER CHEMISTRY.

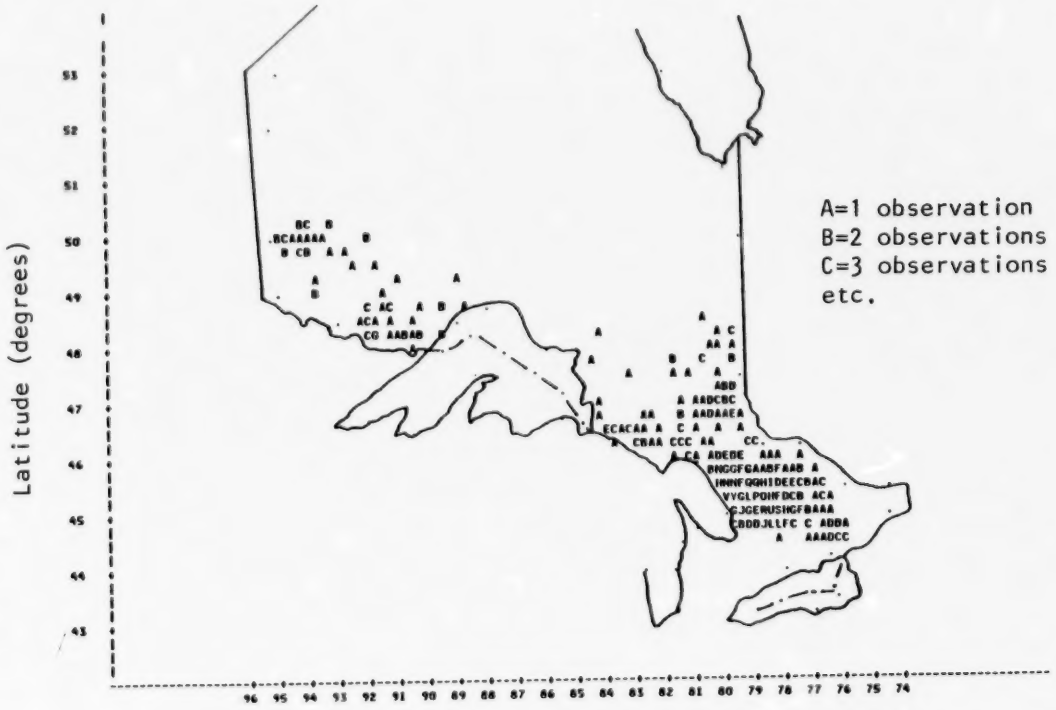


FIGURE 14: DISTRIBUTION OF LAKE WHITEFISH LAKES IN ONTARIO SAMPLED FOR ANALYSIS OF WATER CHEMISTRY.

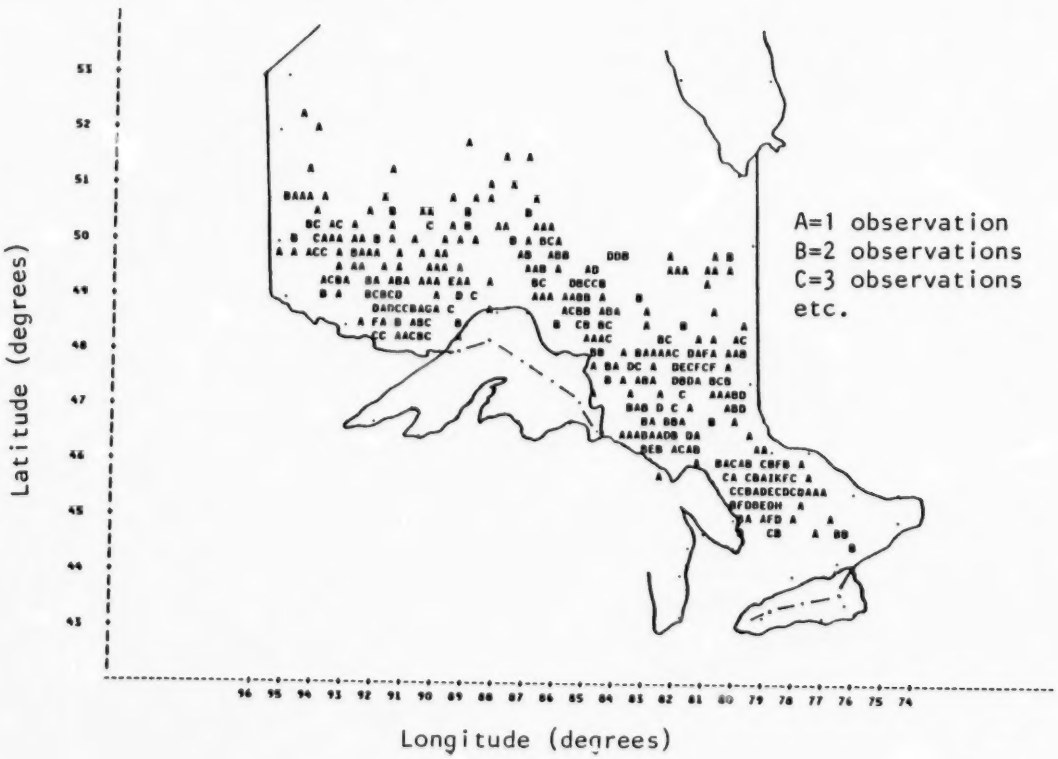
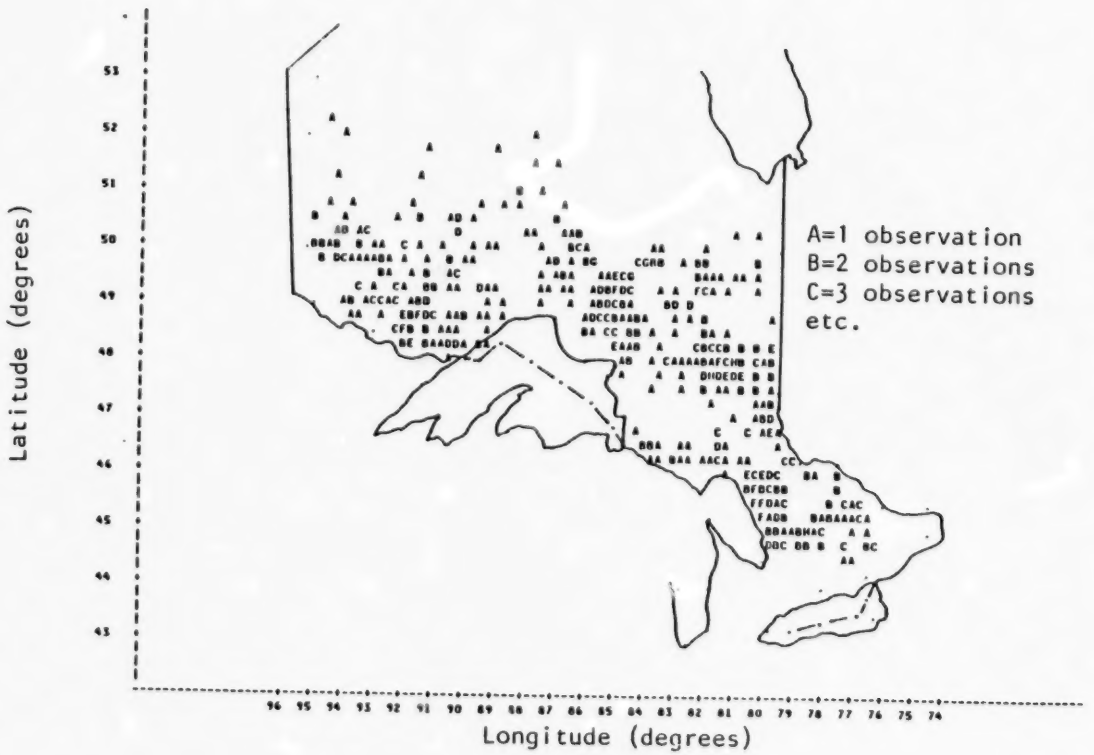


FIGURE 15: DISTRIBUTION OF WALLEYE LAKES IN ONTARIO SAMPLED FOR ANALYSIS OF WATER CHEMISTRY.



APPENDICES

Appendix 1

Abbreviations of chemical and physical parameters used in this report.

LAT	- latitude
LONG	- longitude
WSHED	- watershed
TWP	- township
LKAREA	- lake area
WSHEDA	- watershed area
Yr	- year
Mth	- month
pH	- acidity
TIA	- total inflection point alkalinity (ueq/l)
COND	- conductivity (umhos/cm)
COLAP	- apparent colour of sampled lake (hazen units)
COLTR	- true colour of sampled lake (hazen units)
DOC	- dissolved organic carbon (mg/ml)
CA	- calcium (mg/l)
MG	- magnesium (mg/l)
Na	- sodium (mg/l)
K	- potassium (mg/l)
SO_4	- sulphate (mg/l)
AL	- aluminum (mg/l)
MN	- manganese (mg/l)
Fe	- iron (mg/l)
STDATE	- station date
SPNB	- species number
LT	- lake trout
BT	- brook trout
SMB	- smallmouth bass
LWF	- lake whitefish

Appendix II

Alphabetical listing of all sampled lakes in Northwestern Region

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
1	ABAMATEGWIA LAKE	4940	9154	5QA02		13	1358.9	.	81	7
2	ABRAM LAKE	5002	9200	5QA01	DRAYTON	16	2397.6	.	78	8
3	AEGEAN LAKE	5049	9448	5RB02		15	482.1	.	81	7
4	AEROBUS LAKE	5019	9324	5QE04		11	1948.9	.	81	7
5	AJAX LAKE	4920	9325	5PD06		12	495.0	3360.0	80	8
6	ALSTON LAKE	4936	9239	5QD01	UNORGANIZED	11	.	.	81	8
7	ANDY LAKE	4938	9404	5PD07	MCMEEKIN	14	163.0	1462.4	78	8
8	ARMSTRONG LAKE	4958	9423	5PE01		14	147.0	542.0	81	5
9	BALNE LAKE	4950	9409	5PE04		14	41.0	21318.0	81	5
10	BAMAJI LAKE	5109	9125	4GA12		16	8385.1	.	81	7
11	BARRINGTON LAKE	5016	9018	4GB02	HEATHCOTE	16	1383.8	.	80	8
12	BARTON LAKE	5200	9406	5RC01		15	3695.1	.	81	7
13	BEAK LAKE	4915	9216	5PB12		13	520.0	2752.0	81	5
14	BEARPAW LAKE	4907	9255	5PB08		12	248.0	2325.0	81	5
15	BEAUTY LAKE	5017	9414	5QE01		14	319.0	3095.0	80	6
16	BEAVERHOUSE LAKE	4934	9325	5QD02		11	422.4	.	81	7
17	BEE LAKE	5041	9504	5RA01	(UNORGANIZED)	14	554.7	.	78	8
18	BENDING LAKE	4919	9208	5PB10		13	950.0	13684.0	81	9
19	BERNADINE LAKE	4906	9218	5PB15		12	385.0	2081.0	82	10
20	BERT LAKE	5003	9400	5QE01		14	311.0	3429.0	80	6
21	BIG CANYON LAKE	5005	9346	5QD05		14	2111.0	15780.0	80	6
22	BLINDFOLD LAKE	4940	9415	5PD08	KIRKUP	14	496.5	.	78	8
23	BORNITE LAKE	5019	9328	5QE05		11	521.0	1560.0	80	8
24	BURDITT LAKE	4857	9346	5PB03		12	1421.6	.	81	7
25	BUTTERFLY LAKE	4959	9205	5QA01	JORDAN	16	136.1	.	78	8

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
1	6	7.00	219.0	40	30	.	.	5.0	1.0	1.50	0.55	2.20	.	.	.
2	.	7.39	378.0	.	.	.	.	.	.	.	.	.	.	.	.
3	8	6.65	117.0	25	22	.	.	2.0	1.0	0.72	0.50	.	.	.	.
4	8	7.69	671.8	87	23	.	.	10.0	2.0	1.30	0.91	.	.	.	.
5	1	7.24	332.6	50	13	.	.	6.0	1.0	1.20	0.76	.	.	.	.
6	17	7.88	1182.0	121	.	.	.	.	.	.	.	.	.	.	.
7	.	7.40	494.0	.	.	.	.	.	.	.	.	.	.	.	.
8	1	7.08	196.6	33	13	.	.	3.0	1.0	1.20	0.63	3.70	0.001	0.014	0.087
9	1	6.79	167.8	33	82	.	.	3.0	1.0	1.20	0.82	2.50	0.071	0.027	0.890
10	7	7.23	439.6	56	40	.	.	8.0	1.0	0.69	0.40	.	.	.	.
11	26	6.90	236.0	35	.	.	.	.	.	.	.	.	.	.	.
12	7	7.61	554.8	67	49	.	.	9.0	3.0	1.20	0.69	.	.	.	.
13	1	7.05	183.6	31	16	.	.	5.0	1.0	0.78	0.50	2.80	0.008	0.014	0.070
14	1	6.97	142.4	33	38	.	.	4.0	1.0	1.10	0.35	4.50	0.052	0.013	0.210
15	1	7.04	350.0	47	16	.	.	5.0	1.0	1.30	1.10	2.30	0.022	0.005	0.072
16	5	7.00	253.8	42	42	.	.	7.0	1.0	1.20	0.62	.	.	.	.
17	.	6.89	148.0	.	.	.	.	.	.	.	.	.	.	.	.
18	28	6.95	146.6	29	12	.	.	3.0	1.0	1.00	0.38	3.00	0.030	0.008	0.053
19	28	6.90	201.8	33	48	.	.	3.6	1.0	1.10	0.48	2.60	0.040	0.045	0.270
20	1	7.05	189.6	32	9	.	.	4.0	1.0	1.10	0.57	3.15	0.021	0.004	0.015
21	1	7.33	352.0	50	21	.	.	6.0	1.0	1.40	0.98	3.00	0.026	0.002	0.035
22	.	6.89	172.0	.	.	.	.	.	.	.	.	.	.	.	.
23	13	7.78	701.8	80	9	.	.	10.0	3.0	1.30	1.00	.	.	.	.
24	2	7.48	832.0	96	10	.	.	14.0	1.0	1.10	0.58	4.10	.	.	.
25	.	7.61	860.0	.	.	.	.	.	.	.	.	.	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
26	CALIPER LAKE	4903	9355	5PD04	CLAXTON	12	720.9	.	78	8
27	CALL LAKE	5051	9416	5QE03		15	323.4	.	81	7
28	CATASTROPHE LAKE	4954	9447	5PE03	PELICAN	14	287.6	.	78	8
29	CATHERINE LAKE	4951	9448	5PE03	PELICAN	14	87.9	.	78	8
30	CEDAR LAKE	5009	9308	5QE04		11	2990.0	40960	80	8
31	CLAY LAKE	5003	9330	5QD01	UNORGANIZED	11	3090.2	.	80	8
32	CLIFF LAKE	5010	9318	5QE04		11	2544.0	13148	80	8
33	COBBLE LAKE	4953	9337	5QD05		11	1181.8	.	81	7
34	CRISPIN LAKE	4924	9322	5PD05	UNORGANIZED	11	110.1	.	80	7
35	CROSSROUTE LAKE	4912	9326	5PD03		12	291.0	1400	80	8
36	CYGNET LAKE	5000	9453	5PE03		14	1355.6	.	81	7
37	DELANEY LAKE	5005	9403	5QE01		14	1303.0	3033	80	6
38	DELANO LAKE	4945	9327	5QD02	UNORGANIZED	11	.	.	80	8
39	DIBBLE LAKE	4913	9200	5PB10		13	1163.9	.	81	7
40	DICKER LAKE	4957	9355	5QD05		14	290.0	816	81	5
41	DINORWIC LAKE	4937	9233	5QD01	SOUTHWORTH	11	5169.1	.	78	8
42	DIXIE LAKE	5049	9342	5QC03	(UNORGANIZED)	15	425.3	.	78	8
43	DORE LAKE	4937	9249	5QD02		11	998.6	.	81	7
44	DUMPY LAKE	5019	9404	5QE01		14	352.0	8428	80	6
45	EADY LAKE	5007	9050	5QA09		13	460.5	.	81	7
46	EAGLE LAKE	4942	9313	5QD02	AUBREY	11	27712.9	.	78	8
47	EDEN LAKE	5040	9459	5RA01		14	497.0	2271	80	6
48	ELGA LAKE	5026	9018	4GB02	MCGILLIS	16	97.4	.	80	8
49	ENCAMP LAKE	4916	9106	5QA07		13	475.0	4115	80	9
50	ENGLISH LAKE	4940	9109	5QA04		13	108.9	.	81	7

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
26	.	7.42	610.0	.	.	.	.	.	.	.	.	.	.	.	.
27	8	6.53	121.8	30	38	.	.	4	1.0	0.92	0.44	.	.	.	.
28	.	6.80	133.0	.	.	.	.	.	.	.	.	.	.	.	.
29	.	6.59	148.0	.	.	.	.	.	.	.	.	.	.	.	.
30	13	7.98	887.4	102	15	.	.	13	8.0	1.80	0.97	.	.	.	.
31	8	7.70	714.0	115	.	.	.	.	.	.	.	.	.	.	.
32	1	7.67	710.6	84	9	.	.	6	1.6	1.40	0.88	.	.	.	.
33	1	7.24	367.2	49	15	.	.	6	1.0	1.10	0.73	3.10	.	.	.
34	24	7.25	176.0	33	.	.	.	.	.	.	.	.	.	.	.
35	1	8.00	750.4	84	3	.	.	15	1.0	0.79	0.52	.	.	.	.
36	1	7.25	331.0	49	39	.	.	5	1.0	1.80	1.10	3.10	.	.	.
37	1	7.46	276.6	40	7	.	.	4	1.0	1.20	0.66	3.20	0.026	0.002	0.017
38	11	7.68	292.0	42	.	.	.	.	.	.	.	.	.	.	.
39	6	7.02	143.8	28	17	.	.	4	1.0	1.10	0.40	.	.	.	.
40	1	6.93	133.6	26	8	.	.	2	1.0	1.00	0.43	5.00	0.020	0.007	0.028
41	.	7.58	258.0	.	.	.	.	.	.	.	.	.	.	.	.
42	.	6.99	129.0	.	.	.	.	.	.	.	.	.	.	.	.
43	6	7.48	467.4	63	22	.	.	8	1.0	1.40	0.99	.	.	.	.
44	1	7.09	353.8	48	21	.	.	6	1.0	1.30	0.98	2.60	0.033	0.004	0.041
45	7	6.45	128.2	34	71	.	.	4	1.0	1.00	0.62	.	.	.	.
46	.	7.21	289.0	.	.	.	.	.	.	.	.	.	.	.	.
47	1	7.38	455.0	59	10	.	.	9	1.0	1.20	0.70	2.80	0.031	0.005	0.078
48	20	6.10	38.0	16	.	.	.	.	.	.	.	.	.	.	.
49	30	7.53	422.0	57	25	.	.	7	1.0	1.80	0.86	0.80	0.008	0.037	0.200
50	6	6.93	243.0	39	68	.	.	5	1.0	1.20	0.52	.	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
51	FEIST LAKE	4948	9350	5QD02		11	493.0	1899	81	5
52	FISHER LAKE	4933	9333	5PD05	UNORGANIZED	11	299.7	.	80	8
53	FISHTRAP LAKE	4904	9247	5PB08		12	283.0	1760	81	5
54	FLAMBEAU LAKE	4943	9255	5QD01	AUBREY	11	44.2	.	78	8
55	FLEGG LAKE	4953	9355	5PE04		14	225.0	570	80	6
56	FLET LAKE	5022	9013	4GB02	FLETCHER	16	192.9	.	80	9
57	FLUKE LAKE	5010	9328	5QD01		11	407.8	.	81	6
58	FORGOTTEN LAKE	5004	9421	5QE01		14	226.0	933	81	5
59	GIBI LAKE	4936	9407	5PD08		14	575.5	.	81	7
60	GIBSON LAKE (NL)	4945	9348	5QD02	UNORGANIZED	11	25.7	.	81	9
61	GODSON LAKE	4936	9246	5QD02	(UNORGANIZED)	11	261.8	.	78	8
62	GORDON LAKE	4954	9343	5QD05		11	891.0	2327	81	5
63	GRANITE LAKE	4942	9451	5PD01	BOYS	14	141.8	.	78	8
64	GULLWING LAKE	4955	9235	5QD03	DROPE	11	2428.7	.	81	8
65	HARRIS LAKE	4911	9313	5PB04		12	1292.0	7161	81	5
66	HARTMAN LAKE	4945	9226	5QA01	HARTMAN	11	506.1	.	80	8
67	HAWK LAKE	4947	9359	5PD08		14	958.0	6470	81	5
68	HEAFUR LAKE	5020	9018	4GB02	SHYE	16	369.1	.	80	8
69	HEATHCOTE LAKE	5017	9021	4GB02	HEATHCOTE	16	1185.0	.	80	8
70	HELDER LAKE	5021	9412	5QE02		14	497.0	1761	80	6
71	HERON LAKE	4856	9240	5PB10		12	482.0	7098	81	5
72	HIGH LAKE	4942	9508	5PD09		14	825.0	2862	80	6
73	HIGHBALL LAKE	5024	9133	5QB03	UNORGANIZED	16	318.9	.	80	8
74	HIGHWIND LAKE	4942	9355	5PD07		14	803.0	7809	80	6
75	HILLOCK LAKE	4940	9354	5PD07		14	981.8	.	81	7

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
51	1	6.96	172.8	30	8	.	.	2.0	1.00	0.94	0.38	3.30	0.007	0.002	0.015
52	11	7.70	512.0	60	.	.	.	.	.	.	.	.	.	.	.
53	1	7.01	135.2	28	21	.	.	4.0	1.00	1.00	0.31	3.60	0.044	0.023	0.100
54	.	7.78	684.0	.	.	.	.	.	.	.	.	.	.	.	.
55	1	7.18	138.0	24	1	.	.	3.0	1.00	0.84	0.49	.	0.021	0.003	0.008
56	2	6.90	276.0	40	.	.	.	.	.	.	.	.	.	.	.
57	30	7.68	982.0	102	27	.	.	12.0	3.00	1.80	1.50	2.00	.	.	.
58	1	7.34	226.4	36	7	.	.	5.0	1.00	1.30	0.57	3.90	0.001	0.003	0.011
59	2	7.55	644.0	86	11	.	.	12.0	1.00	1.70	1.40	4.50	.	.	.
60	1	6.50	76.0	22	.	.	.	.	.	.	.	.	.	.	.
61	.	7.22	364.0	.	.	.	.	.	.	.	.	.	.	.	.
62	1	7.10	227.4	35	6	.	.	4.0	1.00	0.89	0.51	3.30	0.004	0.001	0.013
63	.	7.11	219.0	.	.	.	.	.	.	.	.	.	.	.	.
64	11	8.09	1186.0	132	.	.	.	.	.	.	.	.	.	.	.
65	1	7.36	396.2	54	12	.	.	8.0	1.00	0.89	0.48	3.70	0.017	0.007	0.028
66	13	7.65	826.0	100	.	.	.	.	.	.	.	.	.	.	.
67	1	6.88	171.0	36	11	.	.	3.0	1.00	1.50	0.49	5.30	0.040	0.002	0.024
68	26	7.05	242.0	38	.	.	.	.	.	.	.	.	.	.	.
69	26	7.25	254.0	39	.	.	.	.	.	.	.	.	.	.	.
70	1	7.10	192.4	34	11	.	.	4.0	1.00	1.20	0.66	2.75	0.020	0.002	0.016
71	1	6.74	108.8	27	23	.	.	3.0	1.00	0.96	0.38	4.30	0.036	0.021	0.120
72	18	7.60	575.4	72	13	.	.	10.0	1.00	1.40	1.10	3.10	0.018	0.006	0.027
73	27	7.45	532.0	66	.	.	.	.	.	.	.	.	.	.	.
74	1	7.16	189.4	32	14	.	.	4.0	1.00	1.10	0.53	.	0.014	0.003	0.023
75	8	7.33	169.8	32	4	.	.	3.0	1.00	1.10	0.49	.	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
76	HUSTON LAKE	5024	9507	5PF02		14	204.0	671	80	6
77	INDIAN LAKE	4934	9140	5QA05		13	3965.8	.	81	7
78	INDIAN LAKE	5014	9405	5QE01		14	1839.8	.	81	6
79	ISLAND LAKE	4948	9420	5PE04	HAYCOCK	14	331.3	.	78	8
80	ISLETS LAKE	4913	9216	5PB10		13	198.0	582	81	5
81	JIM LAKE	5006	9423	5QE01		14	216.0	9420	81	5
82	JORGENSON LAKE (NL)	4945	9347	5QD02	UNORGANIZED	11	37.4	.	81	9
83	KABAGUKSKI LAKE	4926	9242	5PB04	UNORGANIZED	11	.	.	81	8
84	KAKAGI LAKE	4913	9352	5PD05	PHILLIPS	14	11194.4	.	78	8
85	KAPESAKOSI LAKE	4925	9320	5PD06		11	258.0	1147	81	5
86	KAY LAKE	4913	9128	5QA06		13	362.2	.	82	10
87	KEKEKWA LAKE	4929	9250	5QD02	UNORGANIZED	11	598.3	.	80	8
88	KEYS LAKE	5002	9401	5QE01		14	575.0	2225	80	6
89	KILVERT LAKE	4942	9402	5PD08		14	974.0	5983	81	5
90	KINEWAN LAKE	4902	9243	5PB07		12	352.0	26730	81	5
91	KORPI LAKE	4904	9256	5PB08		12	165.0	3800	81	5
92	LAKE DESPAIR	4852	9340	5PB03		12	912.1	.	81	7
93	LAKE HOPE	4851	9337	5PB02		12	191.0	563	81	5
94	LAVAL LAKE	4948	9227	5QA01	LAVAL	11	286.3	.	78	8
95	LENNAN LAKE	5018	9412	5QE01		14	1355.0	3440	80	6
96	LINGE LAKE	5115	9418	5RB03		15	843.2	.	81	7
97	LITTLE EAGLE LAKE (NL)	4954	9313	5QD02	TEMPLE	11	.	.	80	8
98	LITTLE GORDON LAKE	4953	9345	5QD05	(UNORGANIZED)	11	176.1	.	78	8
99	LITTLE GREEN LAKE (NL)	4940	9327	5QD02	UNORGANIZED	11	132.8	.	80	7
100	LITTLE TURTLE LAKE	4847	9240	5PB10		12	2226.7	.	81	7

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
76	1	6.77	126.6	26	7	.	.	4.0	1.00	1.10	0.49	3.50	0.016	0.004	0.036
77	6	7.48	435.8	60	12	.	.	7.0	5.00	1.80	0.64	.	.	.	.
78	30	7.58	798.0	102	39	.	.	12.0	2.00	2.80	0.81	4.00	.	.	.
79	.	7.04	261.0	.	.	.	.	.	.	.	.	.	.	.	.
80	1	6.80	108.4	24	9	.	.	2.0	1.00	0.80	0.57	3.20	0.012	0.008	0.056
81	1	6.97	273.0	42	27	.	.	4.0	1.00	1.40	0.82	4.70	0.005	0.033	0.220
82	1	6.48	64.0	21	.	.	.	.	.	.	.	.	.	.	.
83	17	8.28	1180.0	125	.	.	.	.	.	.	.	.	.	.	.
84	.	8.15	1020.0	.	.	.	.	.	.	.	.	.	.	.	.
85	1	6.86	132.6	28	20	.	.	2.0	1.00	1.00	0.40	5.70	0.053	0.012	0.140
86	28	6.61	89.8	24	60	.	.	2.3	0.69	0.83	0.34	2.98	0.050	0.016	0.240
87	9	6.76	164.0	32	.	.	.	.	.	.	.	.	.	.	.
88	1	7.33	174.2	32	4	.	.	4.0	1.00	1.20	0.53	3.10	0.014	0.002	0.008
89	1	7.09	190.6	35	17	.	.	3.0	1.00	1.30	0.54	4.30	0.015	0.007	0.039
90	1	7.03	136.0	29	25	.	.	3.0	1.00	0.81	0.43	3.50	0.028	0.010	0.097
91	1	7.37	368.2	55	33	.	.	9.0	1.00	0.94	0.46	4.20	0.043	0.011	0.097
92	2	7.47	862.0	98	28	.	.	14.0	2.00	1.20	0.77	3.60	.	.	.
93	1	7.36	294.4	47	23	.	.	5.0	1.00	1.70	1.00	3.70	0.055	0.025	0.340
94	.	7.69	558.0	.	.	.	.	.	.	.	.	.	.	.	.
95	1	7.52	291.4	40	7	.	.	4.0	1.00	1.30	0.74	2.60	0.016	0.002	0.026
96	8	7.00	196.6	32	24	.	.	3.0	1.00	0.99	0.43	.	.	.	.
97	14	6.75	338.0	43	.	.	.	.	.	.	.	.	.	.	.
98	.	7.26	194.0	.	.	.	.	.	.	.	.	.	.	.	.
99	30	7.63	268.0	35	.	.	.	.	.	.	.	.	.	.	.
100	5	6.98	191.2	35	70	.	.	3.0	1.00	1.20	0.51	4.40	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
101	LOUNT LAKE	5010	9419	5QE01		14	3014.4	.	81	6
102	MAFEKING LAKE	4956	9307	5QD01		11	169.3	.	81	6
103	MALACHI LAKE	4953	9500	5PE03		14	1084.6	.	81	7
104	MANG LAKE	4912	9253	5PB08	UNORGANIZED	12	166.1	.	81	8
105	MANION LAKE	4854	9219	5PB16		12	1120.0	31440	79	6
106	MATHER LAKE	5050	9500	5RA02		15	533.1	.	81	7
107	MISTER LAKE	4908	9315	5PB04		12	211.0	.	81	7
108	NAMEGO LAKE	5007	9429	5QE01		14	206.6	.	81	6
109	OFF LAKE	4854	9349	5PB03	FLEMING	12	459.3	.	78	8
110	OTATAKAN LAKE	5051	9150	5QB04		16	1515.0	.	81	7
111	PAN LAKE	4916	9313	5PD06		12	128.0	10630	81	5
112	PANORAMA LAKE	4858	9349	5PD04		12	493.9	.	81	7
113	PELICAN LAKE	5007	9158	5QA01		16	2343.3	.	81	7
114	PERRAULT LAKE	5018	9308	5QE04	UNORGANIZED	11	3312.9	.	80	8
115	PETTIT LAKE	4857	9216	5PB16		12	1178.0	27050	82	10
116	PICKWICK LAKE	4900	9306	5PB06		12	492.5	.	81	7
117	PINENEEDLE LAKE	5040	9417	5QE02		15	1038.5	.	81	7
118	PORCUS LAKE	4943	9352	5PD07		14	519.0	1822	81	5
119	PRIDE LAKE	5025	9024	4GA18	MCGILLIS	16	93.7	.	80	8
120	PRITCHARD LAKE	4943	9255	5QD01	VAN HORNE	11	40.8	.	78	8
121	RAPID LAKE	5020	9125	5QB01	UNORGANIZED	16	327.5	.	80	8
122	RAHLINSON LAKE	4917	9229	5PB11		11	248.0	1955	81	5
123	RED DEER LAKE	5001	9410	5QE01		14	458.0	3284	80	6
124	REDPATH LAKE	5150	9117	4DA32	UNORGANIZED	16	1137.4	.	80	8
125	ROSS LAKE	5003	9311	5QE04	WAUCHOPE	11	324.1	.	80	8

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
101	30	7.74	756.0	96	41	.	.	12.0	2.00	2.80	0.81	3.40	.	.	.
102	30	6.99	528.0	62	49	.	.	9.0	1.00	1.40	0.66	2.00	.	.	.
103	1	7.18	255.0	41	19	.	.	4.0	1.00	1.50	0.92	3.30	.	.	.
104	17	6.53	166.0	30	.	.	.	.	.	.	.	.	.	.	.
105	1	7.00	220.0	30	15	.	.	3.0	2.00	1.10	0.50	2.50	0.400	0.004	0.070
106	8	6.81	99.8	25	30	.	.	2.0	1.00	0.85	0.42	.	.	.	.
107	5	7.19	467.8	62	9	.	.	9.0	1.00	0.88	0.40	4.60	.	.	.
108	30	6.88	165.2	29	9	.	.	2.0	1.00	1.10	0.55	3.50	.	.	.
109	.	7.70	881.0	.	.	.	.	.	.	.	.	.	.	.	.
110	7	7.36	551.6	70	102	.	.	10.0	3.00	0.83	0.62	.	.	.	.
111	13	6.47	103.0	28	48	.	.	3.0	1.00	1.00	0.38	3.80	0.076	0.022	0.230
112	2	7.35	710.0	80	10	.	.	12.0	1.00	0.98	0.51	2.70	.	.	.
113	7	7.56	515.4	68	33	.	.	9.0	2.00	1.30	0.63	.	.	.	.
114	10	8.29	1126.0	114	.	.	.	.	.	.	.	.	.	.	.
115	28	7.13	182.8	32	21	.	.	3.3	0.79	1.20	0.50	3.81	0.050	0.006	0.055
116	5	7.14	487.0	66	37	.	.	10.0	1.00	0.95	0.61	4.60	.	.	.
117	8	7.30	266.6	45	12	.	.	4.0	1.00	1.20	0.78	.	.	.	.
118	1	6.89	140.0	27	12	.	.	3.0	1.00	0.93	0.41	4.00	0.018	0.003	0.025
119	20	7.35	394.0	52	.	.	.	.	.	.	.	.	.	.	.
120	.	7.51	593.0	.	.	.	.	.	.	.	.	.	.	.	.
121	27	7.35	510.0	61	.	.	.	.	.	.	.	.	.	.	.
122	1	6.49	104.4	25	47	.	.	3.0	1.00	0.89	0.28	2.90	0.052	0.021	0.250
123	1	7.49	217.4	32	1	.	.	4.0	1.00	1.20	0.66	3.40	0.009	0.002	0.012
124	28	7.40	558.0	53	.	.	.	.	.	.	.	.	.	.	.
125	10	7.28	202.0	30	.	.	.	.	.	.	.	.	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR
126	ROUTE LAKE	5004	9238	5QB02	BREITHAUPT	11	1136.3	.	80
127	ROWAN LAKE	4918	9332	5PD06		14	5475.3	.	81
128	RUGBY LAKE	4957	9257	5QD04	RUGBY	11	985.1	.	80
129	SAND LAKE	5005	9439	5PE01		14	7965.2	.	81
130	SANDYBEACH LAKE	4949	9221	5QA01		16	3803.0	.	81
131	SAVANT LAKE	5030	9025	4GA18	SAVANT	16	12041.0	.	80
132	SAVOY LAKE	4916	9101	5QA08		13	570.0	2400	80
133	SCHISTOSE LAKE	4910	9337	5PB03		12	344.7	.	81
134	SCOTTY LAKE	5021	9404	5QE01		14	749.0	5524	80
135	SILVER LAKE	4953	9411	5PE04		14	2550.0	14350	80
136	SILVER LAKE	5025	9022	4GA18	SYME	16	158.6	.	80
137	SNOOK LAKE	5012	9441	5QE01		14	298.0	3564	80
138	SNOWSHOE LAKE	5034	9507	5PJ01		14	1351.9	.	81
139	SOWDEN LAKE	4932	9112	5QA04		13	3721.5	.	81
140	STEWART LAKE (EAST)	4948	9345	5QD02		11	244.0	1129	81
141	STONE LAKE	5026	9130	5QB03	UNORGANIZED	16	220.6	.	80
142	STOUT LAKE	5208	9435	5RC01		15	11355.1	.	81
143	STRONG LAKE	4858	9312	5PB02		12	350.7	.	81
144	SUMACH LAKE	5035	9358	5QE01		15	725.0	.	81
145	SUNSTRUM SPRING LAKE (NL)	5002	9234	5QB02	BREITHAUPT	11	.	.	81
146	SUP LAKE	5017	9333	5QE05	UNORGANIZED	11	679.5	.	80
147	SYDNEY LAKE	5041	9425	5QE02		15	2271.0	54970	80
148	TEGGAU LAKE	4941	9338	5QD02		11	1329.0	7793	81
149	TESUP LAKE	4856	9231	5PB10		12	328.0	5215	81
150	THUNDER LAKE	4947	9240	5QD01	ZEALAND	11	1123.8	.	78

OBS	MONTH	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
126	8	13	7.55	592.0	72	.	.	.	.	.	.	.	.	.	.	.
127	7	2	7.21	444.0	58	8	.	.	8	1	1.30	0.66	3.90	.	.	.
128	8	13	8.39	838.0	94	.	.	.	.	.	.	.	.	.	.	.
129	6	30	7.59	972.0	124	28	.	.	14	4	3.30	0.92	6.40	.	.	.
130	7	6	8.14	1392.4	150	14	.	.	22	3	1.90	1.30	4.40	.	.	.
131	9	2	7.40	368.0	45	.	.	.	.	.	.	.	.	.	.	.
132	9	30	7.23	250.0	37	40	.	.	5	1	1.30	0.70	1.80	0.028	0.022	0.320
133	7	2	7.82	1188.0	132	11	.	.	20	1	1.10	0.51	5.90	.	.	.
134	6	1	7.17	296.6	43	28	.	.	4	1	1.30	1.00	3.50	0.014	0.006	0.070
135	8	1	7.53	234.0	36	4	.	.	3	2	1.10	0.76	.	.	.	.
136	8	20	7.00	372.0	50	.	.	.	.	.	.	.	.	.	.	.
137	6	1	6.66	164.2	33	29	.	.	4	1	1.20	0.70	3.95	0.047	0.006	0.940
138	7	8	6.84	198.6	37	34	.	.	4	1	1.20	0.61	.	.	.	.
139	7	6	7.05	278.4	42	73	.	.	5	1	1.30	0.55	.	.	.	.
140	5	1	7.01	171.4	44	25	.	.	4	1	2.10	0.60	4.60	0.028	0.009	0.075
141	8	27	7.30	584.0	71	.	.	.	.	.	.	.	.	.	.	.
142	7	7	7.33	560.8	68	56	.	.	9	2	1.10	0.77	.	.	.	.
143	7	5	7.00	219.0	40	30	.	.	5	1	1.10	0.73	3.10	.	.	.
144	7	8	7.36	462.4	68	19	.	.	7	2	1.40	1.10	.	.	.	.
145	9	3	8.02	1230.0	118	.	.	.	.	.	.	.	.	.	.	.
146	8	8	7.97	770.0	82	.	.	.	.	.	.	.	.	.	.	.
147	6	1	7.39	276.2	40	18	.	.	5	1	1.10	0.82	3.10	0.020	0.002	0.029
148	5	1	6.87	122.2	25	6	.	.	2	1	0.96	0.42	3.70	0.026	0.001	0.006
149	5	1	6.55	82.6	25	50	.	.	2	1	1.20	0.37	4.60	0.100	0.014	0.180
150	8	.	7.69	650.0	.	.	.	.	.	.	.	.	.	.	.	.

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH
151	TIDE LAKE	5020	9358	5QE01		14	1351.2	.	81	6
152	TRAPLINE LAKE	5030	9457	5PJ01		14	364.5	.	81	7
153	TROUT LAKE	4944	9448	5PE01	GIDLEY	14	259.2	.	78	8
154	TROUT LAKE	4947	9408	5PE04		14	314.0	1657	81	5
155	TROUTFLY LAKE	4951	9227	5QA01		11	200.9	.	81	7
156	UNNAMED CW-1 LAKE (NL)	4944	9353	5QD02	UNORGANIZED	14	.	.	81	8
157	UNNAMED CW-2 LAKE (NL)	4957	9402	5PE04	UNORGANIZED	14	.	.	81	8
158	UNNAMED CW-3 LAKE (NL)	5003	9406	5QE01	UNORGANIZED	14	.	.	81	8
159	UNNAMED CW-4 LAKE (NL)	5036	9357	5QE01	UNORGANIZED	15	.	.	81	8
160	UNNAMED CW-6 LAKE (NL)	4910	9259	5PB04	UNORGANIZED	12	.	.	81	8
161	UNNAMED CW-7 LAKE (NL)	4912	9229	5PB11	UNORGANIZED	11	.	.	81	8
162	UPPER MANITOU LAKE	4920	9245	5PB04	UNORGANIZED	11	.	.	80	8
163	VIRGINIAN LAKE	5025	9020	4GA18	MCGILLIS	16	207.2	.	80	8
164	WABAZIKASKWI LAKE	4936	9110	5QA04		13	695.3	.	81	7
165	WABIGOON LAKE	4944	9244	5QD01	VAN HORNE	11	9930.6	.	78	8
166	WAPAGEISI LAKE	4918	9222	5PB12	UNORGANIZED	11	.	.	80	8
167	WAPESI LAKE	5034	9221	5QB06		16	2368.2	.	81	7
168	WARREN LAKE	4906	9220	5PB10	UNORGANIZED	12	.	.	81	8
169	WHITEWATER LAKE	4859	9244	5PB07		12	352.0	27630	81	5
170	WILKIE LAKE	5024	9015	4GB02	FLETCHER	16	520.4	.	80	9
171	WILLIAMS LAKE	5015	9250	5QB01	UNORGANIZED	11	1539.9	.	80	8
172	WINE LAKE	5026	9319	5QE04	UNORGANIZED	11	.	.	80	8
173	WINKLE LAKE	4901	9258	5PB07		12	382.3	.	81	7
174	WOLFE LAKE (NL)	4924	9314	5QD02	UNORGANIZED	11	.	.	81	8
175	WONDERLAND LAKE	5005	9408	5QE01		14	963.0	7590	80	6

OBS	DAY	PH	TIA	COND	COLAP	COLTR	DOC	CA	MG	NA	K	SO4	AL	MN	FE
151	30	7.59	972.0	88	34	.	.	12	2	1.10	0.76	6.40	.	.	.
152	8	6.78	147.0	30	34	.	.	3	1	0.94	0.63	.	.	.	.
153	.	7.10	188.0	.	.	.	.	.	.	.	.	.	.	.	.
154	1	6.87	127.8	29	14	.	.	3	1	1.10	0.36	3.80	0.010	0.011	0.056
155	6	7.32	711.8	86	19	.	.	13	10	1.10	0.77	3.10	.	.	.
156	12	6.42	70.0	23	.	.	.	.	.	.	.	.	.	.	.
157	12	6.61	104.0	26	.	.	.	.	.	.	.	.	.	.	.
158	12	6.73	164.0	30	.	.	.	.	.	.	.	.	.	.	.
159	12	7.35	388.0	54	.	.	.	.	.	.	.	.	.	.	.
160	17	6.84	152.0	28	.	.	.	.	.	.	.	.	.	.	.
161	17	6.21	64.0	18	.	.	.	.	.	.	.	.	.	.	.
162	9	8.13	724.0	75	.	.	.	.	.	.	.	.	.	.	.
163	26	7.10	402.0	52	.	.	.	.	.	.	.	.	.	.	.
164	6	7.15	238.2	38	74	.	.	4	1	1.20	0.47	.	.	.	.
165	.	7.81	700.0	.	.	.	.	.	.	.	.	.	.	.	.
166	9	7.72	320.0	45	.	.	.	.	.	.	.	.	.	.	.
167	7	7.57	591.2	72	92	.	.	10	2	0.92	0.64	.	.	.	.
168	17	7.37	414.0	50	.	.	.	.	.	.	.	.	.	.	.
169	1	6.91	133.2	28	28	.	.	3	1	0.95	0.46	4.00	0.040	0.007	0.120
170	2	6.65	132.0	25	.	.	.	.	.	.	.	.	.	.	.
171	10	8.67	1618.0	.	.	.	.	.	.	.	.	.	.	.	.
172	8	8.05	826.0	91	.	.	.	.	.	.	.	.	.	.	.
173	5	7.45	395.8	56	10	.	.	8	1	0.74	0.42	4.30	.	.	.
174	10	6.40	82.0	25	.	.	.	.	.	.	.	.	.	.	.
175	1	7.53	243.2	37	6	.	.	4	1	1.30	0.66	3.00	0.022	0.002	0.006

OBS	LAKE	LAT	LONG	WSHED	TWP	DIST	LKAREA	WSHEDA	YR	MONTH	DAY	PH	TIA	COND	COLAPR	COLTOR	DOCA	MG	NA	K	SO4	AL	MN	FE
176	WORTH LAKE	5000	9446	5PE01		14	20.0	360	80	6	1	7.45	259.4	44	5	.	.	4	1	1.7	0.94	3.75	0.001	0.002	0.031
177	ZARN LAKE	5003	9135	5QA01		16	1256.7	.	81	7	7	7.62	554.0	69	15	.	.	9	2	1.0	0.66	.	.	.	.

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ISSN 0832-7629
ISBN 0-7720-1789-2